

Electric Vehicle Charging

Frequently Asked Questions



— With millions of plug-in electric vehicles now on US roads, many more models are on the way, demanding reliable and always-connected EV charging infrastructure.

Why do people buy EVs or invest in electric fleets?

Buyer values include energy cost savings, reducing vehicle GHG emissions, premium performance, latest vehicle technology, energy security and lower maintenance and lifecycle operation costs.

What is a PEV? BEV? PHEV?

All vehicles with a battery that can be recharged from an external source of electricity are considered plug-in vehicles or PEVs. One category of PEV is a BEV, or Battery Electric Vehicle, which is a fully electric vehicle powered by an electric motor with no gas engine, such as the Chevy Bolt, Kia EV6, Hyundai IONIQ 5, Ford Mustang Mach-E, Rivian R1T and all Tesla Models. Another kind of PEV is a PHEV, or plug-in hybrid electric vehicle, which has both a plug-in electric system and a gasoline engine as backup to power the car. Examples include the Jeep Wrangler 4xe, Toyota Prius Prime, Chrysler Pacifica Hybrid Minivan or Chevrolet Volt.

Does any premium paid for buying an EV offset the energy savings over gasoline?

It can, but more so when including vehicle lifecycle costs. Savings are already realized by the lower cost of electricity versus gasoline (MPGe) as well as greatly reduced maintenance. In addition, with the ongoing cost reduction of Li ion batteries, electric vehicles will often deliver a lower cost of ownership versus traditional gas engine vehicles. The more one drives, the more savings can be realized.

The market for plug-in electric vehicles has increased rapidly in recent years and is projected to become significantly larger over the next decade. This document answers common questions about the cars, the technology, the energy and the infrastructure supporting the growing population of EVs around the world.

Electricity is a fossil fuel-based source of energy as well, so are EV's really cleaner?

Yes. Even if your EV is powered by electricity generated by coal, EVs have been shown to have a lower overall lifecycle carbon footprint in terms of both CO₂ and traditional pollutants like nitrogen oxides, carbon monoxide and volatile organic compounds.

Not only is the overall emissions content lower for EVs, but the location and timing of the emissions is better for air quality in high population centers. Gasoline vehicles emit pollution in the middle of the city during the day. The emissions related to EV charging typically happens at off-peak hours at plant locations away from population centers. An EV's carbon footprint is further improved as electricity generation moves to cleaner generation technologies and renewable energy sources; and as more EV owners install solar power that supports their home vehicle charging needs.

How much savings can be achieved when using electricity instead of gasoline?

Driving an EV has been shown to save over \$1000 per year in typical transportation energy costs. When primarily charged at home, electricity costs a fractional amount of the price of equivalent gasoline needs. For example, if electricity rates are 13 cents per kWh; charging an EV for 100 miles of range would cost around \$4. Those same 100 miles would cost



around \$12 in gasoline for a combustion engine car rated at 30 mpg, and a gas price of \$3.50 per gallon. To note, public charging prices will often exceed residential electricity costs for offering the convenience of quick charging away from home.

Do electric vehicles still make financial sense when gas prices go down?

Absolutely; the example above illustrates the gas to electric equation even at a moderate per gallon. In addition, historical price indexes for gasoline are quite volatile as compared to electricity. Figure 1 shows the price index for gasoline by the gallon, versus comparable electricity prices for equivalent energy over the last 45 years. The chart shows that economic, geopolitical and natural disaster events can make a significant impact on the fluctuation of gasoline prices, but electricity has been far less subject to those forces. This is an important distinction for how highly variable energy costs can impact personal finances, but larger national economic and energy security concerns as well.

Do electric cars have the same speed and performance as traditional gas-engine vehicles?

In many cases, even better. While top speeds for EV's are comparable to similarly sized gas-engine vehicles, those powered by electric motors enjoy the inherent benefit of high torque and can get up to traveling speed very quickly. In addition, EV drivers usually express an appreciation for the smooth, quiet and quick performance provided by an electric drive train.

Are maintenance costs higher with an EV?

On the contrary, maintenance costs for EVs have been shown to be significantly lower than comparably equipped gas-powered vehicles. Electric vehicles do not require oil changes, have no transmission or exhaust systems, and have much longer brake life due to their regenerative braking designs. Fewer moving parts and lower vibration mean a lot less wear and tear on the entire vehicle over time. This benefit becomes greater with electric fleet vehicles that drive many more miles and have frequent maintenance intervals.

Will an electric motor last as long as a traditional gas engine?

Longer. Electric motors have been replacing combustion engines for decades in stationary industrial applications for their much higher reliability and efficiency, very low maintenance and emissions, and significantly longer lifetimes. Traditional combustion engine systems that have a thousand or more moving parts are subject to more vibration wear as well as regular maintenance of the supporting fuel, exhaust, fluid and cooling systems. Electric drive trains usually boast fewer than 20 moving parts.

How long does an EV battery last?

Modern lithium-ion battery packs in electric vehicles are estimated to have a serviceable life for 10 years or longer. All electric vehicle manufacturers offer similarly lengthy battery warranties, and most EVs have already shown excellent performance due to sophisticated battery management systems and cooling technologies.

Can EV batteries be recycled?

EV batteries can be recycled and may also find significant after-life use in stationary energy storage applications to manage electricity supply and demand for both utilities and energy consumers.

Is an EV more dangerous in an accident than a gas engine vehicle?

All cars can be dangerous machines due to their power and size, regardless of what gives them energy. Protective features such as seat belts, airbags, and well-engineered 'crumple' zones have saved thousands of lives, but there are also energy-related safety concerns as well. With about 175,000 vehicle fires reported annually in the U.S., gas combustion engines have always faced the risk of flammable petrochemicals igniting due to mechanical and electrical failures or impact. Battery electric vehicles do not have those same combustible fuel concerns.

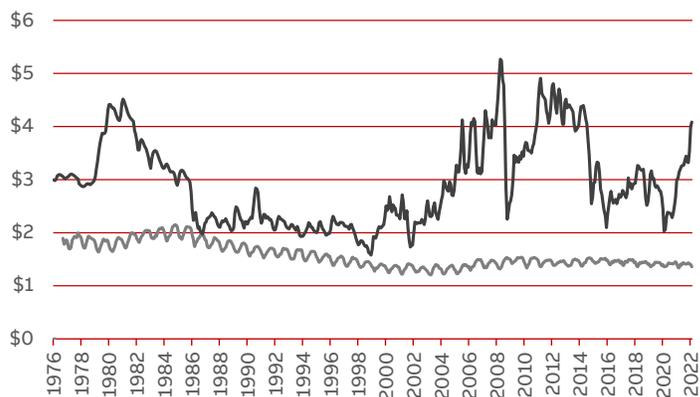


Figure 1: The chart shows the price of gas per gallon (in black) against residential electricity price equivalents (in lighter gray) over a period of over 45 years, in real prices. The electricity data is based on an eGallon equivalent. Price data from U.S. Energy Information Administration, and eGallon calculation from the U.S. Department of Energy.

However, whenever there is stored energy, safety is a paramount consideration. For optimal battery safety, EV automakers engineer sophisticated battery management systems with sensors and protection devices that disconnect the battery prior to the pack sustaining damage. In addition, battery cooling systems are integrated to keep batteries in an optimal temperature range while the car is running to mitigate heat concerns. In their construction, EV batteries are generally organized in an array, modularized into steel-protected sections that further safety objectives.

With millions of EVs now driven around the world, emergency personnel are regularly trained on how to approach electric and hybrid vehicles safely, with standardized response protocols in place in the event of an accident.

Who is ABB E-mobility?

ABB E-mobility is a pioneering technology leader that works closely with charging networks, fleet customers, transit agencies, automakers, utilities and electrical contractors – with more than 1 million EV chargers deployed in over 85 countries. Our EV infrastructure offering complements ABB’s overall power delivery expertise, including our deep experience with power electronics and grid connected systems as well as digitally enabled technologies.

Does ABB E-mobility make electric vehicles?

No, we provide charging infrastructure, both hardware and software, that enables drivers and fleets to charge electric vehicles.

Do I need special infrastructure at my home to charge an EV?

No, all EV’s come with a standard cable for charging in any home outlet. Many EV owners do choose to install

a “Level 2” AC charger at their home to charge their vehicle faster than in a 120 volt outlet. With their higher power features, DC fast charging units are best suited for many public, transit and fleet settings.

How fast do EVs charge?

A standard 120 volt outlet can deliver a charge at about 5 miles of range per hour; a typical 208-240 V AC charger can deliver from 15 to 30 miles of range per hour depending on the power limitations of the charger, the vehicle, and the power supply at the home or facility. DC fast charging systems can fully charge most EVs in 30 to 60 minutes at 120 kW of rated power, and sometimes in less than 15 minutes with higher power technology. Some wallbox style DC chargers will charge at 20-24 KW rated power for power-constrained sites while serving a use case in-between AC and DC fast charging (see Figure 2).

What is the difference between AC and DC charging?

An AC charger supplies AC (Alternating Current) power to a vehicle’s on-board charging device that then charges the EV battery. Faster charging is accomplished with DC (Direct Current) technology. A DC fast charging station converts the grid’s AC supply, delivering power directly to the vehicle battery with no on-board charging infrastructure needed inside the vehicle.

What is the benefit of fast charging?

Case studies of EV adoption rates show that fast public charging is a key component in the successful roll-out of electric vehicles to reduce or eliminate range anxiety. Drivers are more likely to adopt EV technology when they are assured quick charging availability along their regular commutes and intercity travel routes. Additionally, fleets of all sizes and vehicle types are able to implement various fast charging technologies tailored to their routes and business demands.

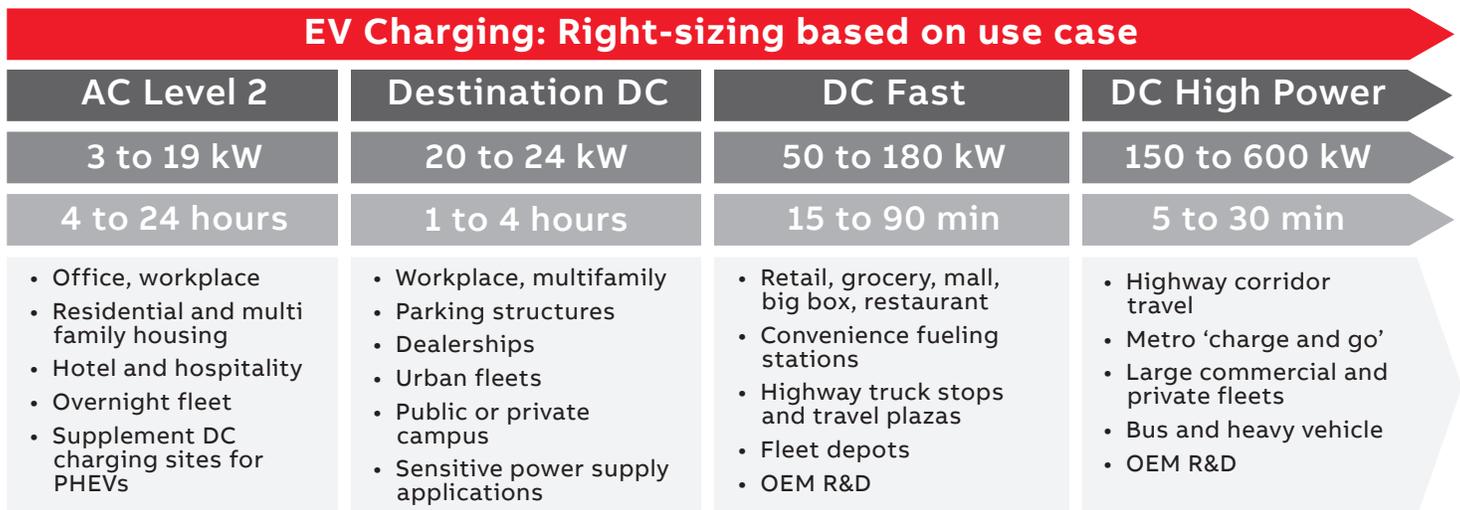


Figure 2: The chart shows common power ratings and average charge times for public EV infrastructure solutions. Variance among power and charge times related to vehicle capabilities (charging protocol, BMS, environmental),

battery capacity (state of charge, overall kWh capacity) and charging hardware power rating. Level 1 charging at 1kW or less is not included in this chart as is limited for most public, fee-based charging applications.

Which vehicles can fast charge?

All passenger and fleet BEV's launched in the North American market over the last few years have fast charging capability. Many more models have been entering the market that will charge at even higher rates such as 150 to 350 kW. However, most PHEV models are limited to AC-only charging.

Why do DC fast chargers “fill” to 80% and not 100%?

Modern lithium ion battery chemistries achieve the longest lifetime when not frequently charged to full capacity. To lengthen the lifetime of EV batteries, DC fast charging protocols provide for quickly getting an EV to 80% of capacity, and then switch to slow trickle charging. This method extends the lifespan of the vehicle battery, gets drivers back on the road sooner, and frees up the charger to serve the next EV.

Does fast charging affect battery longevity?

Not significantly. Multiple studies suggest that battery cycling, that is, frequency of charging, causes some measurable impact on battery lifetime, as all batteries degrade over long periods of time and use. However, charging speed has been shown thus far to have little impact on long term BEV battery performance. Fortunately, automakers build reserve capacity into their battery management designs to buffer against the effects of excessive cycling.

Do multiple fast charging standards hinder EV adoption?

CCS1 and CHAdeMO have been the two open fast charging protocols adopted by most passenger and fleet vehicle manufacturers in North America, although CHAdeMO is not longer implemented on new EV models. ABB E-mobility manufactures DC fast chargers that meet all open standards. Tesla, while proprietary with their charging network, has offered adapters for both of these standards to their drivers.

More recently, many automakers and charging technology providers began to develop the ability to offering NACS within their vehicles and chargers. ABB E-mobility has announced it will incorporate NACS in its North American portfolio. It's clear that open standards and vehicle interoperability are a key



ingredient to the EV industry's ability to scale and grow charging infrastructure while meeting the needs of the most vehicles and their drivers.

Where are DC fast chargers usually installed?

Fast chargers are ideally installed in 'charge and go' locations such as near highways and convenience locations, as well as serving varied fleet charging needs such as transit buses, delivery vans and even medium and heavy duty fleets. They're also commonly found at commercial sites such as shopping centers, restaurants and community parking lots (see Figure 2). These charging locations are growing quickly and can be easily found in smart device apps and websites.

Will a rise in EVs strain the electric grid?

Most EV charging is done at home and work in slower AC voltages, and often not during peak demand hours. With strategies like EV rate incentives and smart charging algorithms, utilities have a fantastic opportunity to use EVs to balance loads while power producers can better balance generation and demand.

At fast charging sites, while more on-demand, there is still an opportunity to leverage time of use, demand response, and power limiting programs to manage demand. In addition, energy storage technologies may offer demand reduction possibilities. ABB is a leader in grid connected technologies, supporting site owners, infrastructure providers and utilities.

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